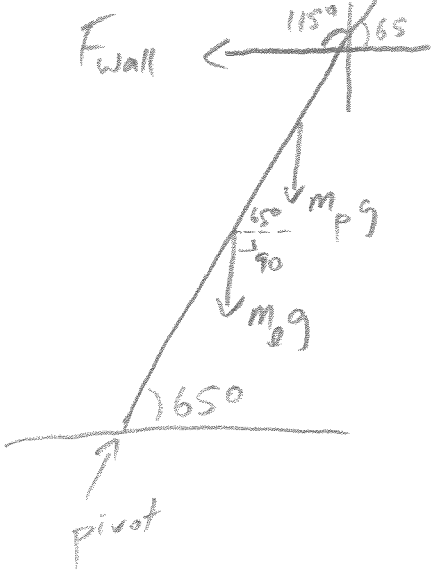
Physics 10154 - Exam #4a b

Partial credit will be given provided you show all work and are solving parts of the problem correctly. Points will be deducted if you don't show your work (or if some parts are incorrect) even if you get the right answer. Clearly indicate your answer with a circle or box and remember to include correct units and significant figures.

1. (30 pts) A 12 meter long, uniform 25-kg ladder rests against a smooth vertical wall. The ladder makes an angle of 65° with respect to the horizontal. If a 550 N person is on the ladder at a distance 8.5 meters from the base of the ladder, what is the force exerted on the ladder by the vertical wall?



$$\Sigma \tau = \tau_l + \tau_p + \tau_{wall} = 0$$

$$\tau_l = -(6.0)(25)(9.8)\sin 155^\circ = -621$$

$$\tau_p = -(8.5)(550)\sin 155^\circ = -1976$$

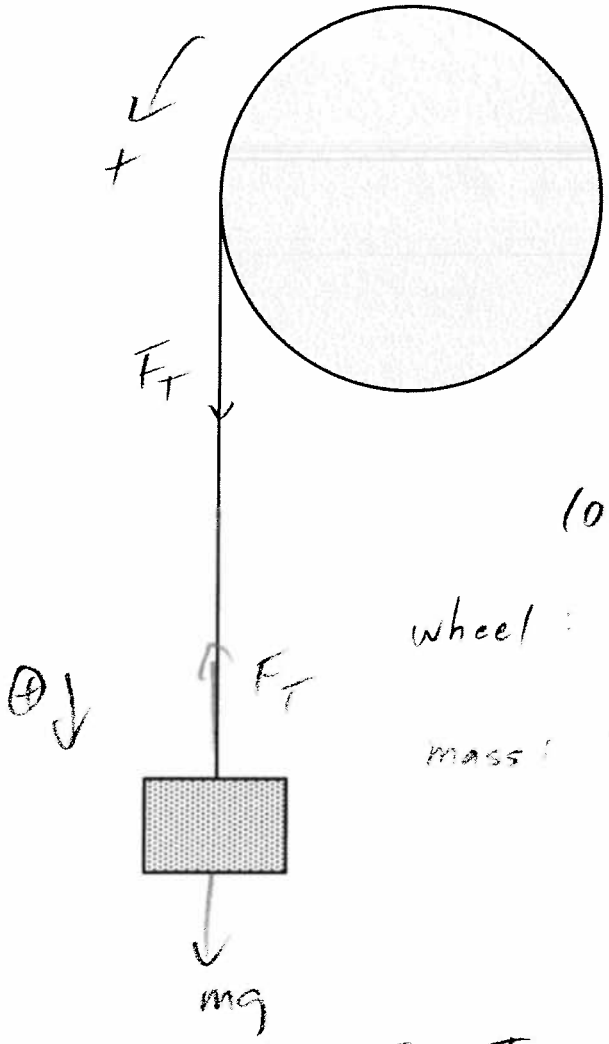
$$\tau_{wall} = +(12)F_{wall}\sin 115^\circ = 10.88F_{wall}$$

$$-621 - 1976 + 10.88F_{wall} = 0$$

$$10.88F_{wall} = 2597$$

$$\boxed{F_{wall} = 240\,N}$$

2. (30 pts) A 120-kg cylinder with a radius of 32 cm has a thin rope wrapped around its edge. As the cylinder rotates about its axis, there is a frictional torque of 12 N-m opposing the motion. The rope is attached to a hanging 15 kg mass, and the system is released from rest. What is the acceleration of the hanging mass as it moves downward?



$$I = \frac{1}{2}MR^2$$

$$= \frac{1}{2}(120)(.32)^2 = 6.144 \text{ kg m}^2$$

$$\Sigma\tau = I\alpha$$

$$\tau_T - \tau_{Fric} = I\alpha$$

$$(0.32)F_T \sin 90 - 12 = 6.144\frac{a}{R}$$

wheel: $0.32F_T - 12 = 19.2a$ I

mass: $\Sigma F_y = mg - F_T = ma$

$= (15)(9.8) - F_T = 15a$

$147 - F_T = 15a$ II

I & II make 2 equations, 2 unknowns

$$F_T = 147 - 15a$$

So $0.32(147 - 15a) - 12 = 19.2a$

$47 - 4.8a - 12 = 19.2a$

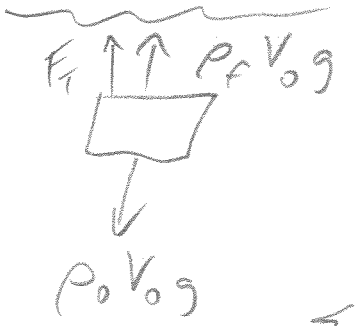
$35 = 24a$ $\boxed{a = 1.5 \text{ m/s}^2}$

$$\alpha = \frac{a}{R} = 4.7 \text{ rad/s}^2$$

3. (40 pts) An object weighs 5500 Newtons in air and 4100 Newtons when immersed in water.

a) What is the density of the object?

b) If the object is released from rest while underwater, how long (in seconds) will it take for the object to fall to the bottom of a container that is 2.5 meters below the object?



$V_f = V_0$ if object is submerged

$$\Sigma F_y = \rho_f V_0 g - \rho_0 V_0 g + F_T = 0$$

$$\rho_f V_0 g - 5500 + 4100 = 0$$

$$F_B = (1000) V_0 g = 1400$$

$$V_0 = 0.143 \text{ m}^3$$

$$\rho_0 (.143)(9.8) = 5500$$

$$\boxed{\rho_0 = 3900 \text{ kg/m}^3}$$

b) $m = \rho_0 V_0 = (3900)(.143) = 560 \text{ kg}$

$$\Sigma F_y = F_B - mg = ma$$

$$1400 - 5500 = 560a$$

$$-4100 = 560a$$

$$\boxed{a = -7.3 \text{ m/s}^2}$$

$\Delta s = -2.5$
$V_0 = 0$
$v = ?$
$a = -7.3$
$t = ?$

$$-2.5 = 0 + \tfrac{1}{2}(-7.3)t^2$$

$$\boxed{t = 0.83 \text{ s}}$$